Bulletin of the Atomic Scientists

ISSN: 0096-3402 (Print) 1938-3282 (Online) Journal homepage: www.tandfonline.com/journals/rbul20

Israeli nuclear weapons, 2014

Hans M. Kristensen & Robert S. Norris

To cite this article: Hans M. Kristensen & Robert S. Norris (2014) Israeli nuclear weapons, 2014, Bulletin of the Atomic Scientists, 70:6, 97-115, DOI: 10.1177/0096340214555409

To link to this article: https://doi.org/10.1177/0096340214555409

Published online: 27 Nov 2015.

Submit your article to this journal

Article views: 14847

View related articles

View Crossmark data

Citing articles: 2 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=rbul20

Bulletin of the Atomic Scientists

IT IS 5 MINUTES TO MIDNIGHT

Nuclear notebook

Bulletin of the Atomic Scientists
2014, Vol. 70(6) 97–115
© The Author(s) 2014
Reprints and permissions:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/0096340214555409
http://thebulletin.sagepub.com

Israeli nuclear weapons, 2014

Hans M. Kristensen and Robert S. Norris

Abstract

Although the Israeli government neither confirms nor denies that it possesses nuclear weapons, it is generally accepted by friend and foe alike that Israel is a nuclear-armed state—and has been so for nearly half a century. The basis for this conclusion has been strengthened significantly since our previous estimate in 2002, particularly thanks to new documents obtained by scholars under the US Freedom of Information Act and other openly available sources.[1] We conclude that many of the public claims about the size of the Israeli nuclear arsenal are exaggerated. We estimate that Israel has a stockpile of approximately 80 nuclear warheads for delivery by two dozen missiles, a couple of squadrons of aircraft, and perhaps a small number of sea-launched cruise missiles.

Keywords

arms race, cruise missiles, Israel, Jericho missiles, Middle East, nuclear weapons, security

Nuclear policy issues

Since the late 1960s, every Israeli government has practiced a policy of nuclear opacity that, while acknowledging that Israel maintains the option of building nuclear weapons, leaves it factually uncertain as to whether Israel actually possesses nuclear weapons and if so at what operational status. Since the mid-1960s, this policy has been publicly expressed—and recently reaffirmed by Prime Minister Benjamin Netanyahu—as the phrase "We won't be the first to introduce nuclear weapons into the Middle East" (Netanyahu, 2011).

This statement is widely seen as a deception, because it is a long-held conclusion among governments and experts that Israel has produced a sizable stockpile of nuclear warheads (probably unassembled) designed for delivery by ballistic missiles and aircraft. Common sense dictates that a country that has developed and produced nuclear warheads for delivery by designated delivery vehicles has, regardless of their operational status, introduced the weapons to the region. But Israeli governments have attached so many interpretations to "introduce" that common sense doesn't appear to apply.

Declassified documents from US–Israeli negotiations in 1968–1969 about the sale and delivery of F-4 Phantom aircraft show that the White House understood full well that "they [Israel] interpreted that ["introduction"] to mean

they could possess nuclear weapons as long as they did not test, deploy, or make them public" (White House, 1969a: 1). In a memo prepared for President Nixon on the Israeli nuclear program, national security advisor Henry Kissinger stated: "This is one program on which the Israelis have persistently deceived us—and may even have stolen from us" (White House, 1969a: 7 of attachment).

Both the Johnson and Nixon administrations tried to get a clearer understanding of the Israeli interpretation of "introduction." During a meeting at the Pentagon in November 1968, Israel's ambassador to the United States, Yitzhak Rabin, who later succeeded Prime Minister Golda Meir as Israeli prime minister, said that "he would not consider a weapon that had not been tested to be a weapon." Rabin noted that this was his personal understanding as a former military leader. Moreover, he said, "There must be a public acknowledgement. The fact that you have got it must be known." Seeking clarity, US Assistant Secretary of Defense Paul Warnke asked: "Then in your view, an unadvertised, untested nuclear device is not a nuclear weapon?" Rabin responded: "Yes, that is correct." So, Warnke continued, an advertised but untested device or weapon would constitute introduction? "Yes, that would be introduction," Rabin confirmed (Department of Defense, 1968: 2, 3, 4).

In a follow-up exchange in July 1969, the Nixon administration plainly summarized its own understanding of the term "introduction": "When Israel says it will not introduce nuclear weapons it means it will not possess such weapons." The Nixon administration wanted Israel to accept the US definition, but the Meir government didn't take the bait and instead claimed: "Introduction means the transformation from a non-nuclear weapon country into a nuclear weapon country" (Department of State, 1969a). In other words, Israel construed its pledge not to be the first to introduce nuclear weapons to mean that that introduction was not about physical possession but about public acknowledgement of that possession.

Kissinger saw a way out of the disagreement: He informed President Nixon that what the Israelis had done was to "define the word 'introduction' by relating it to the NPT [Nuclear Non-Proliferation Treaty]." Kissinger's argument was that the "distinction between 'nuclear-weapon' and 'non-nuclear-weapon' states is the one which the NPT uses in defining the respective obligations of the signatories." By arguing that the NPT negotiations "implicitly left . . . it up to the conscience of the governments involved" by being "deliberately vague on what precise step would transform a state into a nuclear weapon state after the January 1, 1967, cut-off date used in the treaty to define the nuclear states," and by arguing that the NPT does not define what it means to "manufacture" or "acquire" nuclear weapons, Kissinger concluded that the new Israeli formulation "should put us in a position for the record of being able to say we assume we have Israel's assurance that it will remain a non-nuclear state as defined in the NPT" (White House, 1969b: 1).

Kissinger's disingenuous interpretation provided the United States with a way out of a diplomatic dilemma via a tacit understanding between Nixon and Meir that the United States would no longer pressure Israel to sign the Nuclear Non-Proliferation Treaty as long as the Israelis kept their program restrained and invisible—meaning that Israel

would not test nuclear weapons and would not acknowledge in public its possession of such weapons.

The Nixon administration also tried to extract a pledge from Israel on the use of US-supplied aircraft. In the Israeli letter that requested the sale of 50 F-4 Phantoms, Rabin formally promised the United States that Israel "agrees not to use any aircraft supplied by the U.S. as a nuclear weapons carrier" (Embassy of Israel, 1968: 1). A similar promise was made in 1966 in connection with the sale of A-4 Skyhawk aircraft. It is not known if Israel made similar pledges when it acquired F-15 and F-16 aircraft in the 1980s and 1990s, or when it purchased F-35s—which will start to be delivered in 2017.

If a formal pledge was made also for the F-15 and F-16 aircraft, it would appear to rule out Israel currently using US-supplied aircraft in a nuclear strike role. But given the preconditions the Nixon administration discovered Israel had attached to the "no introduction" pledge, Israel may also have attached preconditions to the pledge not to "use any aircraft supplied by the U.S. as a nuclear weapons carrier." What do "use" and "carrier" mean? Do they refer to equipping an aircraft with the *capability* to deliver nuclear weapons or do they refer to the act of *employment* itself? Does the pledge apply to US aircraft modified by Israel? And what does "nuclear weapons" mean? Similar to the interpretation of "introduction," Israel may consider that as long as a nuclear bomb is not assembled nor its existence announced, a US-supplied aircraft is not being used (by Israel's definition) as a carrier of nuclear weapons.

The tacit understanding that the Nixon administration reached with Israel about "introduction" may have resolved a diplomatic conundrum. But it failed to address the core issues: first, that Israel already possessed nuclear weapons, and second, that the United States would be seen as having a double standard when criticizing other Middle Eastern countries for pursuing nuclear weapons while turning a blind eye to Israel's arsenal. And those have been irritants regarding the NPT and Middle Eastern security issues ever since, helping provide excuses for other countries in the region to reject criticism of their own weapons of mass destruction.

On a few rare occasions, some Israeli officials have made statements implying that Israel already has nuclear weapons or could "introduce" them very quickly if necessary. The first came in 1974, when then-President Ephraim Katzir stated: "It has always been our intention to develop a nuclear potential . . . We now have that potential" (quoted in Weissman and Krosney, 1981: 105). Long after his retirement, in a 1981 *New York Times* interview, former defense minister Moshe Dayan also came close to violating the nuclear ambiguity taboo when he declared for the record: "We don't have any atomic bomb now, but we have the capacity, we can do that in a short time." He reiterated the official policy mantra "We are not going to be the first ones to introduce nuclear weapons into the Middle East," but his acknowledgement that "we have the capacity" and would quickly produce atomic bombs if Israel's adversaries acquired nuclear weapons was a hint that Israel had in fact produced all the necessary components to assemble nuclear weapons in a very short time (*New York Times*, 1981).

During a press conference in Washington with US President Bill Clinton and Jordan's President Hussein in 1994,

Israeli Prime Minister Yitzhak Rabin made a similar statement, saying "Israel is not a nuclear country in terms of weapons" and has "committed to the United States for many years not to be the first to introduce nuclear weapons in the context of the Arab-Israeli conflict. But at the same time," he added, "we cannot be blind to efforts that are made in certain Muslim and Arab countries in this direction. Therefore, I can sum up. We'll keep our commitment not to be the first to introduce, but we still look ahead to the dangers that others will do it. *And we have to be prepared for it*" (Rabin, 1994; emphasis added).

The ambiguity left by Israel's refusal to confirm or deny the possession of nuclear weapons prompted the BBC in 2003 to bluntly ask former Prime Minister Shimon Peres whether the ambiguity was just another word for deception: "The term nuclear ambiguity, in some ways it sounds very grand, but isn't it just a euphemism for deception?" Peres did not answer the question but confirmed the need for deception: "If someone wants to kill you and you use deception to save your life, it's not immoral. If we wouldn't [sic] have enemies we wouldn't need deceptions" (BBC, 2003).

Three years later, in a December 2006 interview with German television, then-Prime Minister Ehud Olmert appeared to compromise the deception when he criticized Iran for aspiring "to have nuclear weapons, as America, France, Israel, Russia" (Williams, 2006). The statement, which he made in English, attracted widespread attention because it was seen as an inadvertent admission that Israel possesses nuclear weapons (Williams, 2006). A spokesperson for Olmert later said he had been listing not nuclear states but "responsible nations" (Friedman, 2006).

Ambiguity is not just about refusing to *confirm* possession of nuclear weapons but also about refusing to *deny* it. When asked during a 2011 CNN interview if Israel *does not* have nuclear weapons, Netanyahu did not answer directly but repeated the policy not to be the first to "introduce" nuclear weapons into the Middle East. Undeterred, the journalist followed up: "But if you take an assumption that other countries have them then that may mean you have them?" Netanyahu didn't dispute that but implied that the difference is that Israel doesn't threaten anyone with its arsenal: "Well, it may mean that we don't pose a threat to anyone. We don't call for anyone's annihilation . . . We don't threaten to obliterate countries with nuclear weapons but we are threatened with all these threats" (Netanyahu, 2011).

The nuclear alert

One of the scenarios where Israel might decide to "introduce" its nuclear arsenal is in a crisis that poses a threat to the very existence of the state of Israel. It is widely believed such an incident might have happened in October 1973 during the Yom Kippur War, when Israeli leaders feared Syria was about to defeat the Israeli army in the Golan Heights. The rumor first appeared in *Time* magazine in 1976, was greatly expanded upon in Seymour Hersh's book *The Samson Option* in 1991, and several unidentified former US officials allegedly stated in 2002 that Israel put nuclear forces on alert in 1973 (see e.g., Sale, 2002).

But an interview conducted by Avner Cohen with the late Arnan (Sini) Azaryahu in January 2008 calls into question the validity of this rumor. Azaryahu was senior aide and confidant to Yisrael Galili,

a minister without portfolio who was Golda Meir's closest political ally and privy to some of Israel's most closely held nuclear secrets. In the early afternoon of the second day of the war— October 7, 1973—when the Israeli military appeared to be losing the battle against Syrian forces in the Golan Heights, Azaryahu said that the defense minister, Moshe Dayan, asked Meir to authorize initial technical preparations for a "demonstration option"—that is, ready nuclear weapons for potential use. But Galili and Deputy Prime Minister Yigal Allon argued against the idea, saying Israel would prevail using conventional weapons. According to Azaryahu, Meir sided with her two senior ministers and told Dayan to "forget it" (Cohen, 2013. For analysis of the Azaryahu interview and its implications, see Cohen (n.d.).)

A study by the Strategic Studies division of the Center for Naval Analyses (CNA) in April 2013 appeared to confirm Meir's rejection of Dayan's "demonstration option" and that Israel's nuclear forces were not readied. The report states that even though the authors "did exhaustively scrutinize" the document files of US agencies and archives and interviewed a significant number of officials with firsthand knowledge of the 1973 crisis, "None of these searches revealed any documentation of an Israeli alert or clear manipulation of its forces," and "none of our interviewees, save one, recalled any Israeli nuclear alert or signaling effort" during the Yom Kippur War (Colby et al., 2013: 31–32).

Even so, the single former official who recalled seeing an "electronic or signals intelligence report" at the time that "Israel had activated or increased the readiness of its Jericho missile batteries"—and the extreme government secrecy that surrounds the issue of Israeli nuclear weapons in general—led the authors of the CNA study to conclude that "the United States did observe some kind of Israeli nuclear weapons-related activity in the very early days of the war, probably pertaining to Israel's Jericho ballistic missile force . . . ." (Colby et al., 2013: 34). The study's overall assessment was that "Israel appears to have taken preliminary precautionary steps to protect *or prepare* its nuclear weapons and/or related forces" (Colby et al., 2013: 2; emphasis added).

The conclusion that Israel did something with its nuclear forces in October 1973—although not necessarily place them on full operational alert or prepare for a "demonstration option"—seems similar to the assertion made by Peres in 1995, who in an interview with the authors of *We All Lost the Cold War* "categorically denied that Jericho missiles were made ready, much less armed. At most, he insisted, there was an operational check. The cabinet never approved any alert of Jericho missiles" (Lebow and Stein, 1995: 463, footnote 47).

Evidently, some uncertainty persists about the 1973 events. But then, presumably as well as now, the Israeli warheads were not fully assembled or deployed on delivery systems under normal circumstances but stored under civilian control. And since no official confirmation was made back then either via a test or an announcement, no formal "introduction" of nuclear weapons occurred—at least in the opinion of Israeli officials.

Six years later, on September 22, 1979, a US surveillance satellite known as the Vela 6911 detected what appeared to be the flash from a nuclear test in the southern parts of the Indian Ocean (for background on the 1979 Vela incident, see

Table 1. Israeli nuclear forces, 2014

TYPE	YEAR FIRST DEPLOYED	RANGE (KM)	COMMENT
AIRCRAFT			
F-16A/B/C/D/I Fighting Falcon	1980	1,600	Nuclear bombs posssibly stored at underground facility near Tel Nof Air Base
F-15I Ra'am (Thunder)	1998	3,500	Potential nuclear strike role
LAND-BASED MISSLES			
Jericho II	1984–1985	1,500+	Possibly 25–50 at Zekharia for TELs in caves
Jericho III	?	4,000 ?	In development
SEA-BASED MISSLES			
Dolphin-class submarines	2002 ?	?	Possibly modified cruise missile for land-attack

Richelson, 2006). Despite widespread rumors about Israeli involvement in the test, which would constitute "introduction" of nuclear weapons by the Israeli definition, Israeli governments have continued since to state that Israel would not be the first to introduce nuclear weapons in the region.

How many warheads?

Absent official public information from the Israeli government or intelligence communities of other countries, speculations abound about Israel's nuclear arsenal. Over the past several decades, news media reports, think tanks, authors, and analysts have sized the Israeli nuclear stockpile widely, from 75 warheads up to more than 400 warheads. Delivery vehicles for the warheads have been listed as aircraft, ballistic missiles, artillery tactical or battlefield weapons such as artillery shells and landmines, and more recently sea-launched cruise missiles. We believe many of these rumors are inaccurate and that the most credible stockpile number is on the order of 80 warheads for delivery by aircraft, land-based ballistic missiles, and possibly sea-based cruise missiles (see Table 1).

In 1969, the US State Department concluded: "Israel has moved as rapidly as possible since about 1963" in "developing a capability to produce and deploy nuclear weapons, and to deliver them by surface-to-surface missile or by plane" (Department of State, 1969b: 1; Department of State, 1969c: 3). By 1974, the CIA concluded: "Israel already has produced and stockpiled a small number of fission weapons" (CIA, 1974: 20). "Small" is a relative term; to some analysts it meant an arsenal of a dozen or two dozen weapons, but the public estimate would later balloon significantly.

Most publicly available estimates appear to be derived from a rough calculation of the number of warheads that could hypothetically be created from the amount of plutonium Israel is believed to have produced in its nuclear reactor at Dimona. The technical assessment that accompanied the 1986 *Sunday Times* article about former nuclear technician Mordechai Vanunu's disclosures about Dimona, for example, estimated that Israel had produced enough plutonium for 100 to 200 nuclear warheads (*Sunday Times*, 1986a, 1986b, 1986c).[2] In the public debate, this quickly became Israel *possessing* 100 to 200 nuclear warheads, the estimate that has been most commonly used ever since. There is uncertainty about the operational history or efficiency of the Dimona

reactor's operation over the years, but plutonium production is thought to have continued after 1986, making for a total of roughly 840 kilograms of plutonium for military purposes.[3] That amount could potentially be used to build 168 to 210 nuclear weapons, assuming a second-generation, single-stage, fission-implosion warhead design with a boosted pit containing 4 to 5 kilograms of plutonium.[4]

Total plutonium production is a misleading indicator of the actual size of the Israeli nuclear arsenal, however, because Israel—like other nuclear-armed states—most likely would not have converted all of its plutonium into warheads. A portion is likely stored as a strategic reserve. And given that Israel probably has a limited portion of its aircraft and missiles that are equipped to deliver nuclear weapons, it would in any case not produce many more warheads than it can actually deliver.

And this is where the estimates of 200 to 400 warheads strain credibility. Assuming that Israel has no more than 25 single-warhead land-based ballistic missiles, such a large stockpile would imply as many as 150 to 350 air-delivered bombs, or a significant inventory of other types of nuclear weapons. In comparison, the 180 US bombs deployed in Europe have roughly 20 bombs allocated to each nuclear-capable fighter-bomber squadron. Israel's nuclear posture has not been determined by war-fighting strategy but by deterrence needs, so a more realistic estimate may be that Israel only has a couple of fighter-bomber squadrons assigned to the nuclear missions with perhaps 40 bombs in total.

The higher stockpile estimates appear to come from rumors that Israel has produced a significant number of other types of nuclear weapons, or tactical nuclear weapons. A variety of different sources over the years has claimed, without providing much evidence, that the other weapon types include artillery, landmines, suitcase bombs, nuclear electromagnetic pulse weapons to take out electronic circuits, and enhanced radiation weapons (neutron bombs).[5]

Seymour Hersh's 1991 best-seller, *The Samson Option*: *Israel's Nuclear Arsenal and American Foreign Policy*, claimed that Israel had manufactured "hundreds" (Hersh, 1993: 276) of low-yield neutron nuclear warheads and that at least three nuclear-capable artillery battalions were established after 1973 with self-propelled 175-mm cannons assigned more than 108 nuclear artillery shells. Additional nuclear artillery shells were supplied for Israel's 203-mm cannons. Moreover, Hersh claimed, the warhead that was tested in Israel's suspected nuclear test in 1979 "was a low-yield nuclear artillery shell that had been standardized for use by the Israeli Defense Force" (Hersh, 1993: 271). *The New York Times* reported these claims but also mentioned that the "formal" United States intelligence estimate was "fewer than 100" warheads, quoted the Carnegie Endowment as saying that most outsiders estimated as many as 200 warheads, but ended on Hersh's estimate of an Israeli stockpile of "300 or more" warheads (Brinkley, 1991).

Partly building on these claims, an article published in *Jane's Intelligence Review* in 1997 by photo-interpreter Harold Hough used commercial satellite photos to examine Israel's suspected missile base near the town of Zakharia. The article concluded that the base might house 50 Jericho II missiles and that five bunkers at a nearby depot were capable of storing 150 weapons. "This supports indications that the Israeli arsenal may

contain as many as 400 nuclear weapons with a total combined yield of 50 megatons,") Hough (1997) asserted.[6]

The satellite photos were not very clear, however, and imagery experts later pointed out that "close examination of the published photos indicates that many of these identified features are not visually evident" leaving "large uncertainty associated with these identifications" (Gupta and Pabian, 1998: 97). Possibly indicating similar doubts, a *New York Times* article reminded readers that a Rand Corporation study commissioned by the Pentagon and reported by the Israeli daily newspaper *Haaretz* had concluded that Israel only had enough plutonium to make 70 nuclear weapons (Schmemann, 1998).

The Rand estimate was in the same range as the 60 to 80 nuclear warheads the US Defense Intelligence Agency (DIA) listed in a 1999 classified report (US Defense Intelligence Agency, 1999).[7] Leaked and later published in 2004, this report is to our knowledge the most recent publicly available document that provides an official estimate of how many nuclear warheads Israel has. The report, the timing of which coincided with the commissioning of the first of Israel's six Dolphin-class submarines, also contained a projection for the arsenal by 2020: 65 to 85 warheads.

During the 15 years that have passed since the DIA report, Israel presumably has continued production of plutonium at Dimona for some of that time (although the reactor is getting old) and probably also has continued producing nuclear warheads. Many of those warheads were probably replacements for warheads produced earlier for existing delivery systems, such as the Jericho II missiles and aircraft. Warheads for a rumored Jericho III ballistic missile would probably replace existing Jericho II warheads on a one-for-one basis. Warheads for the rumored submarine-based cruise missile, if true, would be in addition to the existing arsenal but probably only involve a relatively small number of warheads.

Warhead designs

The large variety of warhead designs that would be needed to arm the many different types of launchers rumored to exist—reentry vehicles for ballistic missiles, gravity bombs for aircraft, artillery, landmines, and a neutron bomb—would be a significant technical challenge for a nuclear weapons complex that has only conducted one nuclear test, or even a few tests, 35 years ago.

It took other nuclear weapon states dozens of elaborate nuclear test explosion experiments to develop such varied weapon designs—as well as the warfighting strategies to justify the expense. According to some analysts, Israel had "unrestricted access to French nuclear test explosion data" in the 1960s (Cohen, 1998: 82–83), so much so that "the French nuclear test in 1960 made two nuclear powers not one" (Weissman and Krosney, 1981: 114–117). Until France broke off deep nuclear collaboration with Israel in 1967, France conducted 17 fission warhead tests in Algeria, ranging from a few kilotons to approximately 120 kilotons of explosive yield (*CTBTO*, n.d.; Nuclear Weapon Archive, 2001).

Based on interviews with Vanunu in 1986, Frank Barnaby, a nuclear physicist who worked at the British Atomic Weapons Research Establishment, later said that Vanunu's description of "production at Dimona of lithium-deuteride in the shape of hemispherical shells . . . raised the question of whether Israel

had boosted nuclear weapons in its arsenal" (Barnaby, 2004: 4). Although he didn't think Vanunu had much knowledge about such weapons, Barnaby concluded that "the information he gave suggested that Israel had more advanced nuclear weapons than Nagasaki-type weapons" (Barnaby, 2004: 4).

Barnaby did not mention thermonuclear weapons in his 2004 statement, even though he concluded in his book *The Invisible Bomb* in 1989 that "Israel *may have* about 35 thermonuclear weapons" (Barnaby, 1989: 25). At the time, the director of the CIA apparently did not agree but reportedly indicated that Israel *may be seeking* to construct a thermonuclear weapon (Cordesman, 2005). Yet *The Samson Option* claims that US weapon designers concluded from Vanunu's information that "Israel was capable of manufacturing one of the most sophisticated weapons in the nuclear arsenal—a low-yield [two-stage] neutron bomb" (Hersh, 1993: 199). The authors of *The Nuclear Express* in 2009 echoed that claim, stating that the product of Israel's partnership with South Africa would be "a family of boosted primaries, generic H-bombs, and a specific neutron bomb" (Reed and Stillman, 2009: 174).

While a single-stage, boosted fission design warhead was probably within Israel's technical reach at the time, the claim that Israel also was capable of producing two-stage thermonuclear warhead designs, or even enhanced radiation weapons (which are also two-stage thermonuclear designs), is harder to accept, based on the limited information that is publicly available about Israel's nuclear testing and design history.

Whatever the composition of the Israeli nuclear arsenal, we neither see the indicators that Israel has sufficient nuclear-capable launchers for 200 to 400 nuclear weapons, nor understand why a country that does not have a strategy for fighting nuclear war would need that many types of warheads or warhead designs to deter its potential adversaries. In our assessment, a more credible estimate—taking into consideration plutonium production, testing history, design skills, force structure, and strategy—is an Israeli stockpile of approximately 80 boosted fission warheads.

Aircraft and airfields

Over the past 30 years, the Israeli Air Force (IAF) has had several types of US-produced aircraft capable of carrying nuclear gravity bombs. These include the A-4 Skyhawk, F-4 Phantom, and more recently the F-16 and F-15E. Moreover, Israel has purchased 20 F-35A Lightnings to replace older F-16s, and plans to buy more.

The A-4 and F-4 served long careers as nuclear strike aircraft in the US military, and their potential roles as similar nuclear weapons delivery vehicles within the IAF was the focus of much attention at the time they were in use. As noted earlier, when it bought these aircraft, Israel formally promised the United States that it "agrees not to use any aircraft supplied by the U.S. as a nuclear weapons carrier" (Embassy of Israel, 1968: 1). But the experience with Israel's interpretation of its promise not to be the first to "introduce" nuclear weapons in the Middle East makes it hard to take its promise not to use American aircraft for nuclear missions without a pinch of salt.

Since the 1980s, the F-16 has been the backbone of the Israeli Air Force. Over the years, Israel has purchased well over 200 F-16s of all types, as well as specially

configured F-16Is. Various versions of the F-16 serve nuclear strike roles in the US Air Force and among NATO allies, and the F-16 is the most likely candidate for air delivery of Israeli nuclear weapons at the present time.

Since 1998, Israel has also used the Boeing F-15E Strike Eagle for long-range strike and air-superiority roles. The Israeli version is characterized by greater takeoff weight—36,750 kg—and range—4,450 km—than other F-15 models. Its maximum speed at high altitude is Mach 2.5. The plane has been further modified with specialized radar that has terrain-mapping capability and other navigation and guidance systems. In the US Air Force, the F-15E Strike Eagle has been given a nuclear role. It is not known if the Israeli Air Force has added nuclear capability to this highly versatile plane.

Regardless of what happens with the F-15E, Israel has decided to replace a portion of its F-16 fleet with a new plane under development in the United States: the F-35A. In so doing, it will become the first non-US country to operate the aircraft. The first F-35A—the Israeli version will be known as the F-35I (named "Adir" for "awesome" or "mighty")—will arrive in 2017, with the first squadron expected to become operational at Nevatim Air Base in the Negev desert in 2018. Israel purchased 20 of an earlier F-35 design in 2012, and plans to buy over 100 of the new F-35Is, but the high cost of the F-35 might limit the plans. The F-35I will be adapted with Israeli weapons and has, unlike the F-15I and F-16I, the ability to fly long-range missions with internal weapons. The US Air Force is upgrading its F-35As to carry nuclear bombs, and Israel's Channel 2 reported that an unnamed "senior level US official" refused to say if Israel had requested such an upgrade for its F-35 s (Channel 2, 2014).

It is especially difficult to determine which Israeli wings and squadrons are assigned nuclear missions and which bases support them. The nuclear warheads themselves may be stored in underground facilities near one or two bases. Israeli F-16 squadrons are based at Ramat-David Air Base in northern Israel; Tel Nof and Hatzor air bases in central Israel; and Hatzerim, Nevatim, Ramon, and Ouvda air bases in southern Israel. Of the many F-16 squadrons, only a small fraction—perhaps one or two—would actually be nuclear-certified with specially trained crews, unique procedures, and modified aircraft. The F-15 s are based at Tel Nof Air Base in central Israel, and Hatzerim Air Base in the Negev desert. We cautiously suggest that Tel Nof Air Base in central Israel and Nevatim Air Base in the Negev desert have nuclear missions.

Land-based missiles

Israel's nuclear missile program dates back to the early 1960s. In April 1963, several months before the Dimona reactor began producing plutonium, Israel signed an agreement with the French company Dassault to produce a surface-to-surface ballistic missile. The missile system became known as the Jericho (or MD-620).

The first purchase of 30 missiles occurred in early 1966, but soon after the Six-Day War in June 1967 France imposed an embargo on new military equipment to Israel. Jericho production was transferred to Israel and the first two missiles delivered in 1968, with 10 more by mid-1969. The program was completed around 1970 with 24 to 30 missiles. Apparently not all

were nuclear, with only 10 of the missiles "programmed for nuclear warheads," according to the White House (Department of State, 1968: 2; White House, 1969a: 1).[8] Apparently, the other missiles could be armed with chemical warheads, probably nerve gas (White House, 1969c). The short-range Jericho could deliver a 1,000-kilogram (2,200 pound) reentry vehicle, with a range of about 480 kilometers (298 miles). The accuracy was estimated to be roughly within 926 meters (approximately 0.6 miles) of its target (CIA, 1974: 22).

Most sources assert that Jericho was a *mobile* missile, transported and fired from a transportable erector launcher (CIA, 1974). But there have occasionally been references to possible silos for the weapon. A US State Department study produced in support of National Security Study Memorandum 40 in May 1969 concluded that Israel believed it needed a nearly invulnerable nuclear force to deter a nuclear first strike from its enemies, "i.e., having a second-strike capability." The study stated: "Israel is now building such a force—*the hardened silos of the Jericho missiles*" (Department of State, 1969d: 7; emphasis added). It is not clear that the claim of "hardened silos" constituted the assessment of the US intelligence community, and only a few subsequent sources—all non-governmental—have mentioned Israeli missile silos.[9] We did not find any public evidence of Jericho silos.

The Jericho range was sufficient to target Cairo, Damascus, and all of Jordan, but not the Soviet Union—which was gaining importance in Israel's planning. In collaboration with South Africa, Israel in the late 1980s developed the medium-range Jericho II that put the southern-most Soviet cities and the Black Sea Fleet within range. Jericho II, a modified version of the Shavit space launch rocket, was first deployed in the early-1990s, replacing the first Jericho.

Unofficial estimates of the Jericho II's range vary greatly and tend to be exaggerated—some even up to 5,000 kilometers (3,100 miles).[10] The Jericho was first flight-tested in May 1987 to approximately 850 km (527 miles). The trajectory went far into the Mediterranean Sea. Another test in September 1989 reached 1,300 km (806 miles). The US Air Force National Air Intelligence Center in 1996 reported the Jericho II range as 1,500 kilometers (930 miles) (NAIC, 1996).

Half of Iran, which has increased in importance to Israeli military strategy over the past two decades, is out of Jericho II's reach. That includes Tehran (barely). Rumors abound that Israel has been developing a longer-range missile, publicly known as Jericho III, with an estimated range of 4,000 kilometers, or 2,480 miles. With such a missile, Israel would be able to target all of Iran, Pakistan, and all of Russia west of the Urals—including, for the first time, Moscow. Jericho III was first test-launched over the Mediterranean Sea in January 2008, again in 2011, and most recently in July 2013. Unidentified defense sources told *Jane's Defence Weekly* that Jericho III constitutes "a dramatic leap in Israel's missile capabilities" (*Jane's Defence Weekly*, 2008: 5), but many details and current status are unknown.

How many Jericho missiles Israel has is another uncertainty. Estimates vary from 25 to 100. Most sources estimate that Israel has 50 of these missiles, and place them at the Sdot Micha facility near the town of Zakharia in the Judean Hills approximately 27 kilometers, or about 17 miles, east of Jerusalem. (There are many alternative spellings and names for the

base, including Zekharyeh, Zekharaia, Sdot Micha, and Sdot HaElla.)

Commercial satellite images show what appear to be two clusters of what might be caves for mobile Jericho II launchers. The northern cluster includes 14 caves and the southern cluster has nine caves, for a total of 23 caves. This number of caves roughly matches the 24 to 30 missiles mentioned in a 1969 White House memo (White House, 1969a). Each cluster also has what appears to be a covered drive-through facility, potentially for missile handling or warhead loading. A separate circular facility with four tunnels to underground facilities could potentially be for warhead storage. Consequently, we conclude that estimates of 50 to 100 missiles are exaggerated and estimate that Israel deploys about two dozen mobile launchers for Jericho missiles.

Most reports only mention one missile site, but a US State Department background paper from 1969 stated that there was "evidence strongly indicating that *several sites* providing operational launch capabilities are virtually complete" (Department of State, 1969c: 4; emphasis added). The Sdot Micha base is relatively small at 16 square kilometers, and the suspected launcher caves are located along two roads, each of which is only about one kilometer long. Although this layout would provide protection against limited conventional attacks, it would be vulnerable to a nuclear surprise attack. For the Jericho missiles to have military value, they would need to be able to disperse from their caves.

Sea-based missiles and submarines

Rumors abound that Israel has developed a nuclear warhead for a sea-launched cruise missile, which would be launched from diesel-electric Dolphin-class attack submarines that Israel has acquired from Germany. Some rumors say that the nuclear-capable sea-launched cruise missile is a modification of the conventional "Popeye Turbo" air-to-surface missiles, while others claim that Israel converted the US-supplied Harpoon—a long-standing US anti-ship missile—to nuclear capability.

It is difficult to say with certainty when the rumors first emerged or where, but one early candidate is a Center for Strategic and International Studies study from 1998, which listed: "Variant of the Popeye air-to-surface missile believed to have nuclear warhead" (Cordesman, 1998: 17). There was no source for the claim, but it quickly made its way into *The Washington Times* under the headline "Israel buying 3 submarines to carry nuclear missiles." The article also referenced a June 8, 1998 report in the Israeli paper *Haaretz* "that Israeli military planners want to mount nuclear-armed cruise missiles on the new submarines" (Sieff, 1998).

An article published by Gerald M. Steinberg from Bar Ilan University in *RUSI International Security Review* in 1999 described "unconfirmed reports that Israel is developing a cruise missile (known as the Popeye Turbo) with a range of 350 kilometers, to be operational in 2002," that "could become the basis of a sea-based second strike deterrent" (Steinberg, 1999: 215–224).

When the Clinton administration proposed returning the Golan Heights to Syria, the Israeli government responded with a $17 billion security package request that included 12 long-range BGM-109 Tomahawk sea-launched cruise missiles. (The US Navy possessed a

nuclear-armed version of the Tomahawk between 1983 and 2012.) Israel argued that it would need the Tomahawk to compensate for the loss of strategic depth if it gave up the Golan Heights, although targeting Iran was clearly also a factor. But the Clinton administration turned down the Israeli request in March 2000.

Only three months later, in June 2000, an article in the *Sunday Times* quoted unnamed "Israeli defense officials" as saying that Israel had secretly tested a submarine-launched cruise missile to a range of more than 1,500 kilometers (930 miles) in the Indian Ocean (Mahnaimi and Campbell, 2000).

The reports about a nuclear Popeye cruise missile and a 1,500-kilometer cruise missile test were soon conflated into one missile, which has been referred to as fact in numerous publications ever since. After the widely respected book *Deadly Arsenals* printed this information in June 2002 (Cirincione et al., 2002), coverage in *The Washington Post* added unnamed former Pentagon and State Department officials who confirmed that Israel was arming three newly acquired diesel submarines with "newly designed cruise missiles capable of carrying nuclear warheads." The report said the US Navy monitored the Israeli cruise missile test, although a former Pentagon official cautioned: "It is above top secret knowing whether the sub-launched cruise missiles are nuclear-armed" (Pincus, 2002).

The lead author of the *Sunday Times* cruise missile test article, Uzi Mahnaimi, has written other articles about Israel's nuclear capabilities, some of which later turned out to be incorrect. A 2007 article claimed "several Israeli military sources" had told the *Sunday Times* that two Israeli air force squadrons were training to blow up an Iranian facility using low-yield nuclear "bunker-busters" (Mahnaimi and Baxter, 2007). In 2010, Mahnaimi claimed "the decision has now been taken" to continuously deploy at least one of Israel's "submarines equipped with nuclear cruise missiles . . . in the Gulf near the Iranian coastline." The article quoted an unidentified navy officer saying that the "1,500-km range of the submarines' cruise missiles can reach any target in Iran" (Mahnaimi, 2010). These and other articles have caused media critics, including Marsha B. Cohen on PBS's *Frontline*, to describe Mahnaimi as a "sensationalist" with "a long and consistent record—for being wrong" (Cohen MB, 2010).

Up until 2002, news media reports focused on a naval version of the air-launched Popeye Turbo missile. But in October 2003 the *Los Angeles Times* quoted unnamed US and Israeli officials saying that Israel had modified the US-supplied Harpoon cruise missile to carry nuclear warheads on submarines. "Two Bush administration officials described the missile modification and an Israeli official confirmed it," the paper stated (Frantz, 2003).

This added to the mystery because the range of the Harpoon is even shorter than the range of the Popeye Turbo (110-plus kilometers, or about 68 miles, versus 300-plus kilometers, or about 186 miles). Former Israeli Deputy Defense Minister Efraim Sneh dismissed the Harpoon story:

> Anyone with even the slightest understanding of missiles knows that the Harpoon can never be used to carry nuclear warheads. Not even [Israel's] extraordinarily talented engineers and its sophisticated defense industries can transform the Harpoon into a missile capable of doing this. It's simply impossible. (Haaretz, 2003)

Sneh's claim that "the Harpoon can never be used to carry nuclear warheads"

is not entirely correct. Between 1973 and 1980, the United States considered equipping the Harpoon with a nuclear warhead, but the program was terminated (Cochran et al., 1984). Israel's nuclear weapons engineering capability is much less advanced than that of the United States, and the Pentagon's Defense Security Cooperation Agency, which oversees US military sales abroad, told *Arms Control Today* that although Israel's contract for Harpoon missiles does not explicitly prohibit Israel from modifying them to carry nuclear warheads, "we have had no reason to believe that the government of Israel had any intention to modify or substitute the warheads of these missiles" (Boese, 2003).

Contrary to the Harpoon rumor, the normally well-informed Avner Cohen writes in *The Worst-Kept Secret* that the submarine cruise missile developed for Israel's sea-based strategic leg of its nuclear deterrent has been "developed and built in Israel" (Cohen A, 2010: 83).

Israel plans to operate six Dolphin-class submarines. The last three submarines are 10 meters (approximately 33 feet) longer than the first three due to the addition of an improved air-independent propulsion system. After delivery of the first three submarines, rumors of nuclear capability reportedly prompted Germany to demand that Israel assure that the additional submarines it wanted would not be carrying nuclear weapons (Ben-David, 2005).

Whether the German demand was actually made remains unknown, but in 1999, after delivery of the first Dolphin submarine, then-Prime Minister Ehud Barak told the National Defense College that the submarines "add an important component to Israel's long arm" (Barak, 1999). And the Israeli defense force chief of staff made it clear in 2005 that Israel was modifying its military capabilities in response to Iran's suspected nuclear weapons ambitions. "We cannot sit indifferent in the face of the combination of an irrational regime with non-conventional weapons. We have to concentrate all our efforts to create different capabilities that would allow us both to defend and to react" (Ben-David, 2005: 4).

Colonel Yoni, the head of the Israeli submarine fleet, in 2006 refused to comment on reports about the submarines' rumored nuclear capability but added that "hitting strategic targets is not always a task the Air Force or the infantry can carry out . . . a submarine can perform the mission," he explained. "The fact that foreign reports refer to the submarines as a deterring factor says something" (Greenberg, 2006).

In June 2009, Israeli defense sources reported that the INS *Leviathan*—one of the first three diesel-electric Dolphin-class submarines but *without* the air-independent propulsion of later purchases of submarine—had sailed through the Suez Canal on its way to a naval exercise. Some news media reported the submarine sailed for an exercise in the Persian Gulf, but instead it docked at the Israeli naval base at Eilat in the Red Sea. Speculations erupted about the deployment being a signal to Iran and therefore indirectly a confirmation of the Dolphin-submarine's rumored nuclear capability, and that Israel might deploy submarines permanently at Eilat. But an Israeli defense official said there would be no permanent submarine deployment in Eilat: "If anything, we are scaling down our naval operations in Eilat" (Haaretz, 2009).

Even so, an article published by the *Sunday Times*—written by the same reporter that wrote the article about the

1,500-km cruise missile test and the plans to bomb Iran with low-yield nuclear bombs—claimed that Israel had made a decision "to ensure a permanent presence of at least one" of the Dolphin-class submarines in the Persian Gulf "near the Iranian coastline" (Mahnaimi, 2010).

The German magazine *Der Spiegel* reported in 2012 that the German government had known for decades that Israel planned to equip the submarines with nuclear missiles. Former German officials said they always assumed Israel would use the submarines for nuclear weapons, although the officials appeared to confirm old rumors rather than provide new information. The article quoted another unnamed ministry official with knowledge of the matter: "From the beginning, the boats were primarily used for the purposes of nuclear capability" (*Der Spiegel*, 2012).

Setting the record straight

From these examples, it should be apparent that there is much that is unclear about what kind of nuclear weapons Israel has, how many there are, under what circumstances they would be used, or how they would be delivered to their targets. All Israeli governments have preferred to keep this information secret. Nevertheless, from our examination of the publicly available information, we conclude that widespread claims of an Israeli nuclear stockpile of 200 to 400 warheads and 50 to 100 Jericho missiles are exaggerated.

In our assessment, based on analysis of available sources and examination of commercial satellite imagery, we estimate that Israel has a stockpile of approximately 80 nuclear warheads for delivery by two dozen mobile Jericho missiles, a couple of squadrons of aircraft, and perhaps a small inventory of sea-launched cruise missiles. Much uncertainty remains, however, about the structure and diversity of Israel's nuclear arsenal because of Israel's policy of keeping its nuclear capability ambiguous and because other countries don't reveal some of what their intelligence communities know.

Despite Israel's stated policy that it will not be the first to introduce nuclear weapons in the Middle East, there is little doubt that Israel has already introduced nuclear weapons in the region and that only a deception based on a narrow interpretation of what constitutes "introduction" keeps Israel from officially being a nuclear weapon state. Thanks to invaluable research by researchers such as Avner Cohen and William Burr, previously unknown nuances of Israel's opaque nuclear policy have become available to the public.

Funding

This research was conducted with generous support from the New Land Foundation and the Ploughshares Fund.

Notes

1. For collections of declassified U.S. government documents relating to Israel's nuclear weapons capability, see Cohen and Burr (2006).
2. Frank Barnaby, who cross-examined Vanunu on behalf of the *Sunday Times*, stated in 2004 that the estimate for Israel's plutonium inventory—sufficient for "some 150 nuclear weapons"—was based on Vanunu's description of the reprocessing plant at Dimona (Barnaby, 2004: 3–4).
3. International Panel of Fissile Materials (2013: 20). For additional information about Israeli fissile material production, see International Panel of Fissile Materials (2010: 107–116).

4. The 4 to 5 kilograms of plutonium per warhead assumes high-quality technical and engineering performance for production facilities and personnel. Lower performance would need a greater amount of plutonium per warhead and therefore reduce the total number of weapons that Israel could potentially have produced.
5. For examples of claims about tactical and advanced nuclear weapons, see Hersh (1993: 199–200, 216–217, 220, 268, 276 (note), 312, 319).
6. The 400-warhead claim apparently was based on an earlier article in the same magazine (Brower, 1997).
7. The secret document was leaked and reproduced in Scarborough (2004: 194–223). It is important to caution that as a DIA document, the report does not necessarily represent the coordinated assessment of the U.S. Intelligence Community as a whole, only the view of one part of it. An excerpt from the DIA report is available at Kristensen and Aftergood (2007).
8. Another declassified document at the time stated: "Israel plans to produce and deploy up to 60 missiles" (Joint Chiefs of Staff, 1969: 2).
9. For examples of sources claiming Jericho missiles are deployed in silos, see Cordesman (2008); *Missilethreat.com* (2012). Cordesman references the Nuclear Threat Initiative country profile on Israeli missiles as the source for the silo claim. The NTI has since updated its page, which no longer mentions silos. See: http://www.nti.org/country-profiles/israel/delivery-systems/.
10. For examples of large range estimates for the Jericho II, see Hough (1997: 407 –410); *Missilethreat.com* (2012).

References

Barak E (1999) Address by Prime Minister Barak to the National Defense College. *Israeli Foreign Policy*, August 12. Volume 18: 1999–2001. Available at: http://mfa.gov.il/MFA/ForeignPolicy/MFA Documents/Yearbook13/Pages/24%20Address%20by%20Prime%20Minister%20Barak%20to%20the%20National.aspx.

Barnaby F (1989) *The Invisible Bomb*. London: I.B. Tauris.

Barnaby F (2004) Expert opinion of Charles Frank Barnaby in the matter of Mordechai Vanunu. *Sunday Times*, June 14. Available at: http://fas.org/nuke/guide/israel/barnaby.pdf.

BBC (2003) Israel's secret weapon. March 2003. Available at: http://www.youtube.com/watch?v=z6Aq24Q2xXc.

Ben-David A (2005) Israel looks to acquire more German submarines. *Jane's Defence Weekly*, November 30.

Boese W (2003) Israel allegedly fielding sea-based nuclear missiles. *Arms Control Today*, November 2003. Available at: http://www.armscontrol.org/act/2003_11/Israel.

Brinkley J (1991) Israeli nuclear arsenal exceeds earlier estimates, book reports. *New York Times*, October 20. Available at: http://www.nytimes.com/1991/10/20/world/israeli-nuclear-arsenal-exceeds-earlier-estimates-book-reports.html.

Brower KS (1997) A propensity for conflict: Potential scenarios and outcomes of war in the Middle East. *Jane's Intelligence Review*, special report no. 14, February, pp. 14–15.

Central Intelligence Agency (CIA) (1974) Special National Intelligence Estimate. SNIE 4174. August 23. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB240/snie.pdf.

Cirincione J, Wolfsthal J, and Rajkumar M (2002) *Deadly Arsenals: Tracking Weapons of Mass Destruction*. Washington, DC: Carnegie Endowment for International PeaceAvailable at: http://m.ceip.org/2002/06/12/carnegie-book-release-deadly-arsenals-tracking-weapons-of-mass-destruction/8ggz.

Channel 2 (2014) F-35 Lightning II plane can carry nuclear weapons. March 26. Available at: http://www.mako.co.il/news-military/security/Article-11d7f8f4b2df441004.htm (in Hebrew).

Cochran T, Arkin WM, and Hoenig MM (1984) *Nuclear Weapons Databook Volume I: U.S. Nuclear Forces and Capabilities*. Cambridge, MA: Ballinger.

Cohen A (1998) *Israel and the Bomb*. New York: Columbia University Press.

Cohen A (2010) *The Worst-Kept Secret: Israel's Bargain with the Bomb*. New York: Columbia University Press.

Cohen A (2013) When Israel stepped back from the brink. *New York Times*, October 3. Available at: http://www.nytimes.com/2013/10/04/opinion/when-israel-stepped-back-from-the-brink.html.

Cohen A (n.d.) Arnan 'Sini' Azaryahu. Nuclear Proliferation International History Project, Woodrow Wilson Center. Available at: http://www.wilsoncenter.org/arnan-sini-azaryahu (accessed October 4, 2013).

Cohen A and Burr W (2006) *Israel Crosses the Threshold*. Electronic Briefing Book no. 189, National Security Archive. April 28. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB189/index.htm.

Cohen MB (2010) London's Sunday Times: All the nukes unfit to print? *PBS Frontline*, May 31. Available at: http://www.pbs.org/wgbh/pages/frontline/tehranbureau/2010/05/londons-sunday-times-all-the-nukes-unfit-to-print.html.

Colby E, Cohen A, McCants W et al. (2013) *The Israeli 'Nuclear Alert' of 1973: Deterrence and Signaling in Crisis*. Center for Naval Analysis, April. Available at: http://www.cna.org/sites/default/files/research/DRM-2013-U-004480-Final2.pdf.

Cordesman A (1998) *India, Pakistan, and Proliferation in the Middle East*. Center for Strategic and International Studies, June 3. Available at: http://csis.org/files/media/csis/pubs/prolifinme-brief6-3-98[1].pdf.

Cordesman A (2005) *Proliferation of Weapons of Mass Destruction in the Middle East: The Impact on the Regional Military Balance*. Center for Strategic and International Studies, March 25 (revised draft). Available at: http://csis.org/publication/proliferation-weapons-mass-destruction-middle-east-impact-regional-military-balance.

Cordesman A (2008) Israeli weapons of mass destruction: An overview. 1st working draft, June 2. Available at: http://csis.org/files/media/csis/pubs/080602_israeliwmd.pdf.

CTBTO (n.d.) 13 February 1960 – The first French nuclear test. Available at: http://www.ctbto.org/specials/testing-times/13-february-1960-the-first-french-nuclear-test/ (accessed September 8, 2014).

Department of Defense (1968) Office of the Assistant Secretary of Defense. Memorandum of Conversation, Subject: Negotiations with Israel – F-4 and Advanced Weapons. November 12. Available at: http://www2.gwu.edu/~nsarchiv/israel/documents/battle/12-01.htm.

Department of State (1968) Briefing Memorandum, Parker T. Hart to the Secretary Dean Rusk, Subject: Issues to be Considered in Connection with Negotiations with Israel for F-4 Phantom Aircraft. October 15. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB189/IN-01.pdf.

Department of State (1969a) Memorandum of Conversation, Subject: Israeli Nuclear Program, October 15; enclosure to Elliot L. Richardson, Memorandum for the President, Subject: Israel's Nuclear Program, October 17; attachment to Memorandum, Kissinger to Nixon, Subject: Israel's Nuclear Program, November 6. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB189/IN-25.pdf.

Department of State (1969b) Henry Owen to Secretary, Subject: Impact on U.S. Policies of an Israeli Nuclear Weapons Capability – ACTION MEMORANDUM, February 7. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB189/IN-05.pdf.

Department of State (1969c) Memorandum, U.S. Department of State, Theodore L. Elliott, to Henry Kissinger, Subject: Briefing Book – Visit of Mrs. Golda Meir, September 19. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB189/IN-21.pdf.

Department of State (1969d) I. Israel's Nuclear Weapon Intentions, enclosed as Basic Study to Letter, John P. Walsh, U.S. State Department, to the Assistant to the President for National Security Affairs, et al., Subject: Israeli Nuclear Weapons Program – NSSM 40, May 30. Available at: http://www2.gwu.edu/~nsarchiv/nukevault/ebb485/docs/Doc%206%205-30-69%20NSSM%2040%20report.pdf.

Der Spiegel (2012) Israel's deployment of nuclear missiles on subs from Germany. June 4. Available at: http://www.spiegel.de/international/world/israeldeploysnuclearweaponsongermanbuiltsubmarinesa836784.html.

Embassy of Israel (1968) Letter, Ambassador Lt. Gen. Y. Rabin to Assistant Secretary of Defense Paul Warnke. November 22. Available at: www2.gwu.edu/~nsarchiv/israel/documents/battle/14-01.htm.

Frantz D (2003) Israel adds fuel to nuclear dispute. *Los Angeles Times*, October 12. Available at: http://thehandstand.org/archive/november2003/articles/shamir.htm.

Friedman M (2006) Israel nuke comment sparks controversy. *Associated Press*, December 12. The original article is no longer available online, but a copy is posted here: www.freerepublic.com/focus/f-news/1752227/posts.

Greenberg H (2006) Sub fleet chief: We can hit targets overseas. Ynetnews.com, February 28. Available at: http://www.ynetnews.com/articles/0,7340,L-3221853,00.html.

Gupta V and Pabian F (1998) Viewpoint: Commercial satellite imagery and the CTBT verification process. *The Nonproliferation Review* Spring–Summer: 89–97. Available at: http://kms1.isn.ethz.ch/serviceengine/Files/ISN/114492/ichaptersection_singledocument/2e01aa10-1408-4033-af96-1c78a94f367d/en/Viewpoint04-Gupta.pdf.

Haaretz (2003) Experts scorn report on Israel's nuclear submarines. *Associated Press*, October 13. Available at: http://www.haaretz.com/

print-edition/news/experts-scorn-report-on-israel-s-nuclear-submarines-1.102495.

Haaretz (2009) Israel won't base submarines in Red Sea, says defense official. *Reuters*, July 5. Available at: http://www.haaretz.com/misc/article-print-page/israel-won-t-base-submarines-in-red-sea-says-defense-official-1.279380.

Hersh S (1993) *The Samson Option: Israel's Nuclear Arsenal and American Foreign Policy*. London: Faber and Faber.

Hough H (1997) Could Israel's nuclear assets survive a first strike? *Jane's Intelligence Review*, September: 407–410.

International Panel of Fissile Materials (2010) *Global Fissile Materials Report 2010*. Princeton, NJ: Princeton University, Program on Science and Global Security. Available at: http://ipfmlibrary.org/gfmr10.pdf.

International Panel of Fissile Materials (2013) *Global Fissile Materials Report 2013*. Princeton, NJ: Princeton University, Program on Science and Global Security. Available at: http://ipfmlibrary.org/gfmr13.pdf.

Jane's Defence Weekly (2008) Israel launches leap in IRBM capabilities. January 23.

Joint Chiefs of Staff (1969) Memorandum, Earle Wheeler, Chairman, Joint Chiefs of Staff, to Melvin Laird. March 26. Available at: http://www2.gwu.edu/~nsarchiv/nukevault/ebb485/docs/Doc%204A%205-5-69%20stash%20re%20Feb%201969.pdf.

Kristensen HM and Aftergood S (2007) Nuclear weapons. *Federation of American Scientists*, January 8. Available at: http://fas.org/nuke/guide/israel/nuke.

Lappin Y (2013) IAF will house F-35 fleet at Nevatim base. *Jerusalem Post*, October 1. Available at: www.jpost.com/Defense/IAF-will-house-F-35-fleet-at-Nevatim-base.

Lebow RN and Stein JG (1995) *We All Lost The Cold War*. Princeton, NJ: Princeton University Press.

Lev Kay Y (2009) Israeli sub sails through Suez Canal, sending warning to Iran. *Arutz Sheva 7*, July 5. Available at: http://www.israelnationalnews.com/News/News.aspx/132206#.U_t4vuZdU_A.

Mahnaimi U (2010) Israel stations nuclear missile subs off Iran. *The Sunday Times*, May 30. Available at: https://web.archive.org/web/20110506200452/http://www.timesonline.co.uk/tol/news/world/europe/article7140282.ece.

Mahnaimi U and Baxter S (2007) Revealed: Israel plans nuclear strike on Iran. *The Sunday Times*, January 7. Available at: http://www.informationclearinghouse.info/article18688.htm.

Mahnaimi U and Campbell M (2000) Israel makes nuclear waves with submarine missile test. *Sunday Times*, June 1. Available at: http://fas.org/news/israel/e20000619israelmakes.htm.

Missilethreat.com (2012) Jericho 1/2/3. November 5. Available at: http://missilethreat.com/missiles/jericho-123.

National Air Intelligence Center (NAIC) (1996) *Israel's Satellites and Missiles*. NAIC-ID(RS)T-0568-96. December 18. Available at: http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA321046.

Netanyahu B (2011) Interview with PM Netanyahu on CNN – Piers Morgan Tonight. March 17. Israel Ministry of Foreign Affairs. Available at: http://mfa.gov.il/MFA/PressRoom/2011/Pages/Interview_PM_Netanyahu_CNN_17-Mar-2011.aspx.

New York Times (1981) Dayan says Israelis have the capacity to produce A-Bombs. June 25. Available at: http://www.nytimes.com/1981/06/25/world/dayan-says-israelis-have-the-capacity-to-produce-a-bombs.html.

Nuclear Weapon Archive (2001) France's nuclear weapons: Origin of force de frappe. December 24. Available at: http://nuclearweaponarchive.org/France/FranceOrigin.html.

Pincus W (2002) Israel has sub-based atomic arms capability. *Washington Post*, June 15. Available at: http://www.converge.org.nz/pma/cra0532.htm.

Rabin Y (1994) Press Conference with President Clinton, King Hussein, and Prime Minister Rabin, the White House. July 26. *Israel's Foreign Relations*, Selected Documents, Volume 13–14, 1992–1994, Israel Ministry of Foreign Affairs. Available at: http://mfa.gov.il/MFA/ForeignPolicy/MFADocuments/Yearbook9/Pages/215%20Press%20Conference%20with%20President%20Clinton-%20King.aspx.

Reed T and Stillman D (2009) *The Nuclear Express: A Political History of the Bomb and Its Proliferation*. Minneapolis, MN: Zenith Press.

Richelson J (2006) The vela incident: Nuclear test or meteorid? *Electronic Briefing Book* no. 190, National Security Archive, May 5. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB190.

Sale R (2002) Yom Kippur: Israel's 1973 nuclear alert. *UPI*, September 16. Available at: http://www.upi.com/Business_News/Security-Industry/2002/09/16/Yom-Kippur-Israels-1973-nuclear-alert/UPI-64941032228992/print.

Scarborough R (2004) *Rumsfeld's War*. Washington, DC: Regnery.

Schmemann S (1998) Israel clings to its 'nuclear ambiguity.' *New York Times*, June 21. Available at: http://www.nytimes.com/1998/06/21/world/israel-clings-to-its-nuclear-ambiguity.html.

Sieff M (1998) Israel buying 3 submarines to carry nuclear missiles. *Washington Times*, July 1. Available at: http://fas.org/nuke/guide/israel/sub/internatl1.html.

Steinberg G (1999) *Re-examining Israel's Security Doctrine*. RUSI International Security Review. London: Royal United Services Institute for Defence Analysis. Available at: https://faculty.biu.ac.il/~steing/arms/doctrine.htm.

Sunday Times (1986a) Inside Dimona, Israel's nuclear bomb factory. October 5.

Sunday Times (1986b) Revealed—The secrets of Israel's nuclear arsenal. October 5.

Sunday Times (1986c) How the experts were convinced. October 5.

US Defense Intelligence Agency (1999) *A Primer on the Future Threat: The Decades Ahead: 1999–2020*. The document was leaked. An excerpt is available at: http://fas.org/nuke/guide/israel/nuke.

Weissman S and Krosney H (1981) *The Islamic Bomb: The Nuclear Threat to Israel and the Middle East*. New York: Times Books.

White House (1969a) Memorandum, Henry Kissinger to Richard Nixon, Subject: Israel's Nuclear Program. July 19. Available at: www2.gwu.edu/~nsarchiv/nukevault/ebb485/docs/Doc%2010%207-19-69%20circa.pdf.

White House (1969b) Memorandum, Kissinger to Nixon, Subject: Israel's Nuclear Program. November 6. Available at: http://www2.gwu.edu/~nsarchiv/NSAEBB/NSAEBB189/IN-25.pdf.

White House (1969c) Talking paper for the Deputy Secretary of Defense and the Chairman, Joint Chiefs of Staff (Meeting of the Ad Hoc Committee of the NSC Review Group). June 20. Attachment to Memorandum, Jeanne Davis, Secretariat, National Security Council, to Under Secretary of State Richardson, et al., June 5. Available at: http://www2.gwu.edu/~nsarchiv/nukevault/ebb485/docs/Doc%207.pdf.

Williams D (2006) Israel's Olmert under fire over nuclear remarks. *Washington Post*, December 12. Available at: http://www.washingtonpost.com/wp-dyn/content/article/2006/12/12/AR2006121200463_pf.html.

Author biographies

Hans M. Kristensen is the director of the Nuclear Information Project with the Federation of American Scientists (FAS) in Washington, DC, USA. His work focuses on researching and writing about the status of nuclear weapons and the policies that direct them. Kristensen is a co-author of the world nuclear forces overview in the *SIPRI Yearbook* (Oxford University Press) and a frequent adviser to the news media on nuclear weapons policy and operations. He has co-authored Nuclear notebook since 2001. Inquiries should be directed to FAS, 1725 DeSales St. NW, Sixth Floor, Washington, DC 20036, USA; (202) 546-3300.

Robert S. Norris is a senior fellow with the Federation of American Scientists in Washington, DC, USA. A former senior research associate with the Natural Resources Defense Council, his principal areas of expertise include writing and research on all aspects of the nuclear weapons programs of the United States, the Soviet Union and Russia, the United Kingdom, France, and China, as well as India, Pakistan, and Israel. He is the author of *Racing for the Bomb: General Leslie R. Groves, the Manhattan Project's Indispensable Man* (Steerforth, 2002) and co-author of *Making the Russian Bomb: From Stalin to Yeltsin* (Westview, 1995). He co-authored or contributed to the chapter on nuclear weapons in the 1985–2000 editions of the *SIPRI Yearbook* (Oxford University Press) and has co-authored Nuclear notebook since 1987.